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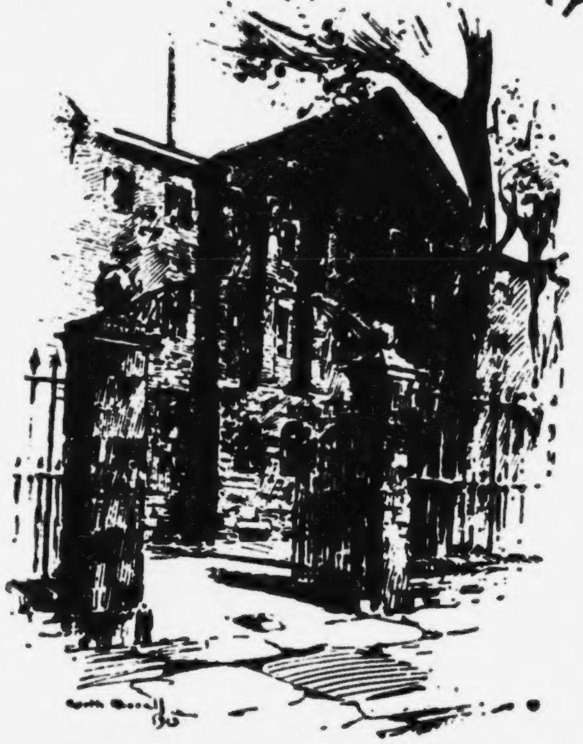

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ILLUSTRATIONS

ASTRONOMY,

BY HENRY HAYDEN, S. T. P.

A. M. *of Trinity College, Dublin, [illegible] Presbyter of the*
United Church of England and Ireland.

> [illegible] citharâ crinitus Iopas
> Personat aurata, docuit quae maximus Atlas.
> Hic canit errantem lunam, solisque labores;
> Unde hominum genus, et pecudes; unde imber, et ignes;
> Arcturum, pluviasque Hyades, geminosque Triones;
> Quid tantùm Oceano properent se tinguere soles
> Hiberni, vel quae tardis mora noctibus obstet.
> Ingeminant plausu Tyrii, Troësque sequuntur.
>
> VIRGIL.

TRANSLATION.

> The Goblet goes around: Iopas brought
> The golden lyre, and sang what ancient Atlas taught.
> The various labours of the wandering Moon,
> And whence proceed th' Eclipses of the Sun;
> Th' original of men and beasts; and whence
> The rains arise, and fires their warmth dispense,
> And fixed and erring stars dispose their influence.
> What shakes the solid Earth, what cause delays
> The Summer nights, and shortens Winter days.
> With peals of shouts the Tyrians praise the song;
> Those peals are echoed by the Trojan throng.
>
> DRYDEN.

HALIFAX:
PRINTED AT THE TIMES OFFICE.
1836.

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PREFACE.

ASTRONOMY, confessedly the Mistress and Queen of Sciences, from a Greek derivative, signifying the Law of the Stars, is a Science which treats of the motions, periods, magnitudes, eclipses, and other phenomena of the heavenly bodies. The fine regions of Asia, the first abodes of mankind, were peculiarly calculated to favour the growth of Astronomy. This sublime Science was much cultivated by the Chaldeans ; the level and extensive plains of Babylonia, the nights passed in the open air, an unbroken horizon, a pure and serene sky, all conspired to engage that nation to cultivate this noble science, to contemplate the motions of the stars, and to lead them to conjecture on the laws by which they were governed. The Prophet Isaiah in his usual sublime strain, thus addresses the Inhabitants of the devoted Babylon,—" Will your astrologers, star-gazers, and monthly prognosticators, save you from all those evils which are coming on you !" The upper story of the immense temple of Jupiter Belus, in Babylon, the ruins of which now tower over the plains in inexpressible grandeur, was used as an observatory.

Aristotle, the disciple of Plato, and tutor of Alexander, (called the Great,) tried to discover the figure and magnitude of the Earth; he proved it of a spherical form by its circular shadow on the disc of the Moon, in eclipses. Calisthenes, who attended Alexander to Babylon, found observations for 2,000 years previous to his visit, and sent them to Alexander. Pythagoras taught the true system of the Universe, 500 years B. C., which after the lapse and errors of many centuries, was revised by Copernicus, and is now settled on the basis of proofs that can never be disturbed; the only opposition that Copernicus found was from Tycho Brahe, a celebrated Danish astronomer. His system nearly resembles that of Ptolemy the Egyptian. In defence of Tycho it may be stated, that though he adopted an erroneous theory, he was actuated by pious motives, and that he rendered great service to Astronomy by the correctness and number of his observations. John Kepler was the pupil of Tycho, and a man of a truly original and admirable genius, who by his great sagacity, superior talents and industry, has made discoveries of which no traces can be found in the annals of antiquity. Galileo was contemporary with Kepler, and from the results of their united labours, Newton and others were afterwards enabled to establish the most complete theories of the Planetary motions. Though Galileo clearly proved the annual and diurnal motion of the Earth, his doctrine was declared heretical by an assembly of Cardinals; and though not only venerable for his years, but excellent in reputation, he was condemned to perpetual incarceration, for believing and divulging truths which strictly accorded with the order of Nature, and which he believed to have been written with the finger of the Almighty. In the year 1642 he died, after suffering much misery, regretted by the learned and liberal of all Europe. The tribulation in which the great Kepler lived, or rather starved, forms a most painful contrast to the eminent services he performed to science. The pension allotted to him, trivial in itself, was always in arrear; and although the three Emperors whose reigns he adorned, directed their ministers to be more punctual in their payments, the non-payment was a source of continual vexation to Kepler. When he retired to Sagan, in Silesia, to spend the evening of his days, his difficulties became more harassing. Dire necessity, the urgent calls of a famishing family, compelled him to apply personally for the arrears, and he set out in 1630 for Ratisbon; but in consequence of the great fatigue which so long a journey on horseback produced, he was seized with typhus fever, of which he died on November 30, 1630, in the 59th year of his age. I have dreaded to inquire what became of his family after his decease. Such is the usage good and great men too frequently experience in this present evil world. Next on the stage comes an admirable youth, Jeremiah Horrox, a celebrated English Astronomer of the 17th century, the pride and boast of British Astronomy. He was born at Toxteth, near Liverpool, in 1619, and educated at Emanuel College, Cambridge; he began in 1633, in his fourteenth year, to study Astronomy, and accurately observed the Transit of Venus, November 24, 1639, but died suddenly January 3, 1640, only a few days after he had finished his celebrated treatise, "Venus in Sole visa." His other posthumous productions were collected and published by Dr. Wallis, Savilian Professor at Oxford, in 1673. Horrox was the first to observe the passage of Venus over the Sun's disc, and his theory of Lunar motions afforded assistance to Newton, who at all times spoke of him as "an admirable genius of the highest order"; now perhaps not a stone tells where he lies. In 1633 he began to study Astronomy, but the narrow circumstances of this highly gifted young man retarded for three years his scientific labours. About the year 1636, he became acquainted with Mr. Wm. Crabtree, of Manchester, whose genius led him to the study of Astronomy, with whom Mr. H. corresponded, and they communicated their discoveries to Mr. Foster, Professor of Gresham College. Mr. H. with the assistance of his friends, who kindly furnished him with books and instruments, now pursued his studies with renewed vigour, and applied with great diligence to making celestial observations. Horrox and Crabtree corresponded,—the former at Hool, near Liverpool, England, the latter at

Manchester, observed the Transit of Venus, November 24, (old style) 1639; and although Horrox was not aware at the time of the great use that would be made of this important observation, in demonstrating the distance of the Planets from the Sun, and his parallax, yet he made from it many highly useful improvements on the Planet Venus. He was also eminently successful in his theory of the Lunar motions. His "Venus in Sole Visa," with his own "Mercurius in Sole Visus," were published by Helvetius, at Dantzic, in 1662, and illustrated with notes by that eminent Astronomer. His remaining works, published as before stated, bear the title of "Opera Posthuma." Mr. Horrox, in my judgment, exhibited talents of the highest order, and I have no doubt that had it pleased the Almighty, in whose hands are the issues of life and death, to prolong his valuable life to the usual age of man, he would have rivalled if not have excelled all his predecessors, and all his successors also, Kepler and Newton not excepted. Next comes the Illustrious Newton, in Astronomy a star of the first magnitude, who was born at Woolsthorpe, in Lincolnshire, six miles south of Grantham, on the 25th of December, (old style,) 1642. His father, Mr. Isaac Newton, died at the early age of 36. Newton was an unusually small infant, his mother said at his birth he might fit in a quart mug; still he lived to extreme old age, to 85, and never wore spectacles, though so severe a student. Newton when a boy was fond of making sun-dials, clocks and other pieces of mechanism, and was very studious. On the 7th June, 1660, he entered Trinity College, Cambridge; the optics of Kepler were his favourite study—the celebrated Dr. Barrow was his tutor. In 1665 he took the degree of Bachelor of Arts, and the next year, as the plague broke out he returned home. The grand object of his studies was to remedy the imperfection of Telescopes. This by great perseverance he accomplished, leaving to Herschell and to Ramage of Aberdeen, to bring reflecting Telescopes to the greatest perfection. Newton was knighted by Queen Anne, in 1705, and was held in the highest respect at the court of George I; the Princess of Wales, Caroline, Queen to George II, a literary lady, was delighted with his society, and blessed God that she lived in his days. His manners were pleasing and simple, no trace of pride or ostentation at his great attainments. He was extremely absent, would sit for an hour at his bed side on rising, absorbed in thought, and was in the habit of travelling with his hands extended out of each of the windows of his coach. In his food he was very temperate, abstemious in the use of wines, and frequently forgot the time of his meals till reminded. The celebrated Mr. Locke was his friend. Mr. Locke had not a taste for mathematics, therefore he made no progress in practical Astronomy. It is pleasing to the Christian to rank both these great philosophers in the list of believers in Christianity ; they both wrote Commentaries on certain parts of the Scriptures—Sir Isaac Newton on part of the Prophecies, and Locke on St. Paul's fine Epistle to the Romans, in the exposition of which he has exhibited his great powers of reasoning and research. Mr. Locke was in every respect an excellent and an exemplary Christian ; he lived to his 73d year, and had his trials and persecutions in the tyrannical days of Charles II, who would have taken off his head for daring to write on liberty, had he not escaped to Holland, where he remained till the revolution. The University of Oxford, complying with the mandate of a corrupt court, to their eternal disgrace, in November 1684, at the King's express instance, (who died suddenly, Feb. 6, 1685,) expelled that great philosopher from his lucrative place as Student of Christ Church, whose works have since been their greatest pride and glory ; so are the best men treated, by those who shamefully abuse their power and are insensible to merit.

Sir Isaac Newton is supposed to have had little knowledge of the world ; sharpers and swindlers could have cheated him with the greatest ease, but he gave them no opportunity. Mr. Conduit, his nephew, says he had a very lively and piercing eye, a comely aspect, with a fine head of hair as white as silver. Bishop Atterbury (in my opinion a much superior judge,) says on the contrary, that the lively eye did not belong to Newton for the last twenty years of his life ; nor was there in his countenance that penetrating sagacity that appears in his writings. He had somewhat rather languid in his look and manner, which did not raise expectation in those who did not know him. He was full of thought (as all learned men are) and spoke little in company. There is a fine bust of him at Cambridge, and several good paintings ; as may be imagined every memorial of so great a man " an honor and an ornament to human nature," is preserved, and will be preserved with the greatest care. He died on March 20, 1727 ; his body lay in state, and was interred sumptuously in Westminster Abbey, and though said to be very liberal he died rich, worth upwards of thirty thousand pounds sterling. To those who desire further information, I refer to his life, lately published by Sir David Brewster, a work written with great ability and perspicuity. We will now commence our labours on Astronomy.

ILLUSTRATIONS OF ASTRONOMY.

> " ——— So when the Moon, refulgent lamp of night,
> O'er heaven's clear azure spreads her sacred light,
> When not a breath disturbs the deep serene,
> And not a cloud o'ercasts the solemn scene ;
> Around her throne the vivid planets roll,
> And stars unnumbered gild the glowing pole.
> O'er the dark trees a yellower verdure shed,
> And tip with silver every mountain's head ;
> Then shine the vales ; the rocks in prospect rise ;
> A flood of glory bursts from all the skies ;
> The conscious swains, rejoicing in the sight,
> Eye the blue vault, and bless the useful light."
>
> Pope's Homer.

LETTER I.

Having seen an article in a late paper, stating that certain Astronomers in Germany had discovered a colossal edifice in the centre of the Moon—also traces of roads, cultivation, and clear indications of inhabitants in certain latitudes of that Planet, or Satellite to our Earth ; having taken much pains for many years past, and occupied my time and attention in that most interesting study, I must declare my doubts of the truth of those discoveries. Schræter, (a celebrated German Astronomer,) lately deceased at an advanced age, occupied much time in investigating the surface or disc of the Moon and Venus. He published the results of his labours, which were similar to those we now discuss. Had these men brought a few witnesses to their discoveries, we would surely believe them ; this, however, they declined, and for that special reason I dissent. Schræter has published a Map of the Moon, the best on record, in which he notices the height of its mountains ; one named Leibnitz, he makes twenty-five thousand feet high, which is nearly equal to the height of the Himalayan, which divides India from Thibet, (the highest on our globe.) He also states that he had discovered Twilight in the Moon, her having an atmosphere being denied by a great majority of the best Astronomers of all ages. He also states his discovery of Mountains, five and six-fold higher than any on our earth, in the Planets Venus and Mercury. Now we know that Venus has a disc as resplendent as a fixed star; and Dr. the father of Sir John Herschel, tells us, that having examined the disc of Venus and of Mercury also, for a series of years, with the best Telescopes, even with his great forty-feet reflector, he has never been able to see or observe any inequalities on the disc of Venus or of Mercury. He says that the height of the Lunar mountains has been greatly over-rated. His discovery of Volcanoes in the Moon, as far back as the year 1789, soon after the completion of his great Telescope, I have no doubt of. Two were in action, ejecting ashes, quite visible, and a third extinct. I am now studying the latest treatise on Astronomy, by the present Sir John Herschell—his valuable work is worthy the talented son of a celebrated father, who indulged in no visionary speculations, but truly told the result of his discoveries. Those amongst the Fixed Stars, by the power of his Telescopes, are truly wonderful.

In Chap. 6, Section 362, last Edition of Herschell's Astronomy, the author says,—"The physical constitution of the Moon is better known to us than that of any other Planet. By the aid of Telescopes we perceive inequalities in its surface, which must be mountains and vallies; from experiments by the micrometer, of the length of the shadows of many of the most conspicuous, their heights have been calculated—the highest being rather under two miles. The existence of such Mountains is corroborated by their appearance as small points or islands of light, beyond the extreme edge of the enlightened parts, which are their tops catching the sunbeams, and which as the light advances, at length connect themselves with it, and advance from the outer edge.

Section 363. "The generality of Lunar mountains present a striking uniformity of aspect; they are wonderfully numerous, occupying by far the greater portion of the surface, and almost universally of an exactly circular or cup-shaped form. They offer in its highest perfection the true volcanic character, as may be seen in the Crater of Vesuvius; and in some of the principal ones, decisive marks of volcanic stratification, arising from deposits of ejected matter, may be clearly traced with powerful Telescopes. What is moreover extremely singular in the Geology of the Moon is, that although nothing having the character of Seas can be traced, (for the dusky spots which are commonly called seas, when closely examined present appearances incompatible with the supposition of deep water,) yet on its surface are large regions perfectly bare, and apparently of a decided alluvial character. The Moon has no clouds, or any other indication of an atmosphere; were there any it would not fail to be observed in the occultation of Stars, and the Phenomena of Solar Eclipses—hence its climate must be very extraordinary; the alternations being that of unmitigated and burning sunshine, fiercer than an equatorial noon, continued for a whole fortnight; and the keenest severity of frost, far exceeding that of our polar winters, for an equal time. The consequence must be absolute aridity below the vertical sun, constant accretion of hoar frost in the opposite region, and perhaps a narrow zone of running water at the borders of the enlightened hemisphere. It is possible then, that the evaporation on the one hand, and condensation on the other, may to a certain extent, preserve an equilibrium of temperature, and mitigate the extreme severity of both climates.

Section 365. "A Circle of one second in diameter, as seen from the Earth on the surface of the Moon, contains about a square mile.—Telescopes must therefore be greatly improved before we could expect to see signs of inhabitants, as manifested by edifices, or by changes on the surface of the soil. Owing to the want of air, however, it seems impossible that any form of life similar to those on earth can subsist there; no appearance indicating vegetation or the slightest variation of surface, which can fairly be ascribed to change of season, can any where be discerned. The lunar summer and winter arise in fact from the rotation of the Moon on its own axis—the period of which rotation is exactly equal to its siderial revolution about the Earth, and is performed in a plane inclined to the Ecliptic, and therefore nearly coincident with her own orbit. This is the cause why we always see the same face of the Moon, and have no knowledge of the other side ;—if there be inhabitants in the Moon, this Earth must present to them the extraordinary appearance of a Moon of nearly two degrees in diameter, exhibiting the same Phases as we see the Moon to do,—but immoveably fixed in their Sky, while the Stars must seem to pass slowly beside and behind it—it will appear clouded with variable spots, and belted with equatorial and tropical Zones, corresponding to our trade winds ; and it may be doubted whether in their perpetual change the outlines of our Continents and Seas can ever be clearly discerned." The diameter of the Moon is supposed 2,200 miles—her distance from the Earth 240,000 miles. Herschell's great Telescope brings her to within forty miles, as seen by the naked eye. Even suppose that there may be a small degree of atmosphere in the Moon, (if we credit the observations of Schræter,) a man could not long exist there. The late Baron Humboldt, the most scientific of Travellers, ascended Chimborazo, one of the highest of the Andes. His ascent was nineteen thousand five hundred feet, the highest point of earth ever trodden by Man—the highest pinnacle of the Mountain was fifteen hundred feet higher, to which an immense chasm, five hundred feet wide, filled with snow, hindered the ascent of himself and friends. On that vast height, by reason of the extreme rarity of the air, blood issued from their lips, and they could breathe with great difficulty. An ascent to the Crater of the Volcanic mountain Catapaxi, they describe as unattainable by any human efforts. That Volcano, 20,000 feet high, is the highest on Earth, vomiting streams of lava and sulphuric flames over the Kingdom of Quito—to the destruction of towns and villages, the ravages of which, with the great liability to Earthquakes, render a residence in that vicinity no desirable object.

LETTER II.

The Theories respecting the Moon can only be set at rest by the improvement of Telescopes—the time may not be very remote when we can ascertain the truth. In my humble judgment she has neither an atmosphere, animals, or vegetation; indeed the only kind of proof we have of air in the Moon, is the statement of Schræter, that he had observed Twilight in the Moon at a certain period. Great credit is due to that talented Astronomer, for his laborious and long continued observations on the Moon and the Planet Venus. The result we shall give, and are concerned to find so much disagreement between his observations and those of Sir William Herschell. Venus and Mercury both exhibit Phases like the Moon; this was foretold by the great Kepler, the improver of the Copernican system of Astronomy. Kepler also proved that the motion of the Planets was elliptical; before his time they were supposed to be circular. That great Philosopher, styled (and justly styled) "Illustrious," was rewarded with a small pension by one of the German Princes. The pension was ill paid, he and his family often suffered severely, and at length exhausted by care and poverty, he deceased in the fifty-ninth year of his age. leaving the glory of his name, and that alone, to his family. The Transits of Venus are of rare occurrence, taking place at intervals of 8 and 113 years. They offer the best means of ascertaining the Sun's distance from the Planets, and so important has this observation appeared to Astronomers, that at the last Transit of Venus in 1769, expeditions were fitted out on the most efficient scale, by the British, French, Russian, and other Governments, to the most remote quarters of this Earth, for the express purpose of observing the Transit or passage of Venus over the Sun's disc. Under the auspices of George the Third, who patronized Astronomy, the celebrated Capt. Cook sailed to Otaheite for that purpose. The first who ever observed a Transit of Venus was Horrox, a youth of admirable talents, who died in his 22d year, in the reign of Charles I., at the time of the civil wars, after affording indubitable proofs of his capacity and taste for this sublime science. He constructed Tables of the movements of Venus, proved the exact time of her transit, and wrote a tract of singular ability on the occasion, entitled "Venus in sole visa,"—a tract that has signalized his memory, as much as Kepler's celebrated treatise on the Planet Mars, has added to the high reputation of that great Astronomer. To the memory of Horrox we may well apply the latter lines of the pathetic address to the shade of Marcellus, by Virgil :—

> "Heu miserande puer ! si quà fata aspera rumpas,
> Tu Marcellus eris. Manibus date lilia plenis :
> Purpureos spargam flores, animamque nepotis
> His saltem accumulem donis, et fungar inani
> Munere."

The Planets Mercury, Venus, Mars, Jupiter and Saturn, have been known from the first ages of Astronomy. Uranus (in heathen mythology the father of Saturn,) was discovered by the late Sir William Herschell, in 1781, March 13, in the course of a review of the Heavens, in which every Star visible was brought under close examination, when the new Planet was discovered by its disc under a high magnifying power. It has since been ascertained to have been observed on many previous occasions, with Telescopes of insufficient power to exhibit its disc ; and even entered in catalogues as a Star of the sixth magnitude. The discovery of the smaller Planets dates from the first day of the year 1801, when Ceres was discovered by Piazzi, at Palermo ; soon after Juno, by Professor Harding, at Gottingen ; and Pallas and Vesta, by Dr. Olbers, of Bremen. It was conjectured by the late Professor Bode, of Berlin, as probable, that a Planet might exist between Mars and Jupiter. Great, however, was the wonder of Astronomers to find four Planets revolving regularly in ellipses like the greater Planets, round the Sun. The force of heat from the Sun's rays, is seven-fold as great on Mercury as on the

Earth, and on the outermost Planet Uranus 330 times less—the proportion of the extremes being two thousand to one. Quitting the region of speculation, we will now see what information the Telescope affords us. Of Mercury we can say little more than that it is round, and exhibits Phases like the Moon. It is too small, and too much immersed in the Sun's rays, to form just observations; besides, spots are not observable on its disc (though this is doubted,) as on Venus; its rotation on its axis can hardly be determined; its real diameter is 3,200 miles, its distance from the Sun thirty-seven millions of miles—which will give our readers some idea of the immense distances in our calculations. The diameter of our Earth is 7,900 miles; that of Venus 100 miles less.—Venus is the most difficult of them all to define with Telescopes. The intense lustre of her illuminated part dazzles the sight, and exaggerates the imperfections of Telescopes. Yet we see clearly, that her surface is not mottled over with permanent spots like the Moon,—we perceive in it (in England at least) no mountains, but a uniform brightness, in which we may at times fancy obscurer parts. It is from observations of this kind, that we may conclude both Venus and Mercury revolve on their axis in about the same time as our Earth. The most natural conclusion however is, from the very rare appearance and want of permanency in the spots, that we do not see as in the Moon, the real disc or surface of these Planets, but only their atmospheres much loaded with clouds, and which may serve to mitigate the otherwise intense glare of their sunshine. The case is very different with Mars. In this Planet we discern with perfect distinctness the outlines of Continents and Seas; of these the former are distinguished by a ruddy colour, which indicates no doubt, a tinge of ochre in his soil, like what the red sandstone tracts on our earth may offer to the inhabitants of Mars, but more decided: contrasted with this, by a general law in optics, the seas appear green.—This Planet has an atmosphere and clouds, and there appear brilliant white spots at its poles; *these must be snow*, as they disappear when long exposed to the Sun, and are most visible when first emerging from the long night of his polar winter. Mars has a rotation on his axis; his real diameter is 4,100 miles. I have seen all these phenomena of Mars, in an achromatic Telescope of great power, at the Observatory of Armagh, Ireland, in the winter of the year 1818.

Of all the Planets, Saturn presents us with the most singular example, when viewed through a powerful Telescope. He appears surrounded by a double concentric Ring, separated by a space of nearly 3000 miles, and distant 30,000 miles from the surface of Saturn. The Rings revolve round the Planet at the rate of a thousand miles per minute. These Rings of immense breadth, are only one hundred miles thick. These luminous Rings must afford a magnificent and a brilliant spectacle to the inhabitants of that Planet. During his fifteen years summer the night must be enlivened by the bright reflection of this brilliant arch, extending its luminous curve from the eastern to the western horizon, while even during the day the Sun must be materially assisted by its light.—There is no Planet in the Solar System, whose firmament will present such a variety of splendid objects as that of Saturn. The various aspects of his seven Moons, one rising above the horizon while another is setting ; a third approaching the meridian ; one entering into an eclipse, while another is emerging from it ; one approaching as a crescent, and another gibbous ; and sometimes all of them shining together in one bright assembly ; the majestic motion of the rings, at one time illuminating the sky with their splendour, and even eclipsing the stars,—at another time casting a deep shade over certain portions of the Planet, and opening to view the wonders of the starry firmament, are scenes worthy of the majesty of the Almighty Creator to unfold, and of his creatures to contemplate, and to fill their hearts with devout gratitude and praise for his wondrous works. The elder Herschell has been very fortunate in his observations on Saturn ; he gives all the dimensions of the Planet and of his Rings.—It is certainly the most wonderful object in our Solar System. In the event of the perfection of Telescopes, we will know much more of his Moons, and those of Jupiter, four in number, and highly interesting also. In reference to the immense size of these Planets, *all* the Moons are required, while one is sufficient to light our smaller Planet. Though certain German Astronomers *pretend* they have observed a Moon to Venus, on the closest observations by the best Astronomers, with the most powerful Telescopes, none has been seen either in its place in her firmament, or accompanying her on her Transit over the Sun's disc. The opinions of Kepler, Horrox, Herschell, and Schræter, are, that she has no Moon, nor have Mercury or Mars. How the absence of Moons may be remedied, we know not.

LETTER III.

OMITTING a description of the extra Zodiacal Planets, Juno, Ceres, Pallas and Vesta, until we shall arrive at the observations of Schræter and Herschell on them, we now proceed to Jupiter, the largest of the Planets, generally supposed ninety-four thousand miles in diameter—stated by Sir Wm. Herschell, at eighty-seven thousand, by Brewster, at eighty-two thousand ; even the lowest computation, (the last,) would prove Jupiter's diameter to that of the Earth, as upwards of one thousand to one. Jupiter has four Moons or Satellites, frequently eclipsed ; the third (the largest,) 3,377 miles in diameter, larger by 1,177 miles than our Moon ; the fourth 2,890 miles in diameter ; the first and second are less, but as large as our Moon, each exceeding two thousand miles in diameter. These may well be imagined very magnificent objects, and highly useful to the inhabitants of that stupendous globe. The disc of Jupiter is always observed to be crossed in one direction by dark bands or belts ; these belts present dissimilar aspects at divers times—they vary in breadth and situation on the Planet's disc, though never in their general direction ; they have even been observed broken up, and distributed over the entire face of the Planet—but this is rare. Dark spots like clouds are also seen ; and from close observation of those spots, with glasses of the highest powers, it is concluded that Jupiter revolves on his axis in the surprisingly short period of ten hours, (less by five minutes) on an axis perpendicular to the direction of his belts. That it is the dark body of the Planet that appears in the belts, is evident from this, that they do not come up in all their strength to the edge of the disc, but fade away gradually before they reach it.—His Moons offer a visible disc with good telescopes. Schrœter doubts our ever having exposed to view the disc of Jupiter—like the Sun he remains covered with a hazy atmosphere which intercepts our view.

I have referred in my last Letter to Saturn, to which Planet the late Sir William Herschell directed much laborious attention for a series of years, and improved in a great degree our knowledge of that singular Planet.—Saturn is allowed to be seventy-nine (some astronomers make him eighty-nine) thousand miles in diameter, nearly one thousand fold exceeding our Earth in bulk—one-eighth only of the density of our Earth—less dense than Jupiter. This immense globe, besides being attended by seven Satellites or Moons, is surrounded with two broad, flat, extremely thin rings, concentric with the Planet and each other, both lying in one plane. Saturn has also belts like Jupiter. I observed these belts or clouds, five of seven Satellites, and the double rings distinctly visible; also the four magnificent Moons of Jupiter, (the discovery of which by Galileo was the first fruits of the Telescope,) at the Observatory of Armagh, Ireland, in the winter of 1818, where I passed six weeks making observations, assisted by the best achromatic telescopes, imported from Germany. That the Ring is a solid opaque substance is evident, by its casting its shadow on the body of the Planet, on the side nearest the Sun.—Dark spots are also apparent at intervals, which closely observed with powerful Telescopes, like the spots on Mars, Jupiter and Venus, indicate the rotation of Saturn on his axis in ten hours and twenty-nine minutes. It may very naturally be asked, how so stupendous an arch, if composed of solid materials, can be sustained without falling in upon the Planet. The reply will be found in the swift rotation of the Ring in its own plane, which close observation has detected, owing to certain portions of the Ring being less bright than others. It is the centrifugal force arising from this rotation, that sustains the Ring. The Rings of Saturn must present a most magnificent spectacle from those regions of the Planet which lie above their enlightened sides, as vast arches spanning the sky, and holding an invariable situation amongst the Stars. On the other hand, in the regions beneath the dark side, a solar eclipse of fifteen years in duration, must afford (as we suppose) an inhospitable asylum to animated beings ; ill compensated by the faint light of the Satellites. But we cannot judge of the fitness or unfitness of their condition from what we observe around us, when perhaps the very combinations which convey to our minds only images of horror, may in reality be theatres of the most striking and glorious displays of beneficent contrivance. Of Uranus, the last, or furthest Planet from the Sun, we see only a small round uniformly illuminated disc, without rings, belts, or discernible spots, its real diameter (all astronomers agree) is thirty-five thousand miles, its bulk eighty-fold that of our Earth ; it is attended by Moons, two at least, and probably four more, whose orbits are remarkable. Five of the Satellites of Saturn are visible with Telescopes of high power. The two interior, which just skirt the edge of the Ring, and move exactly in its plane, have never been seen but with the most powerful Telescopes that human art has ever formed ; and then only under very peculiar circumstances. Owing to the obliquity of the Ring, there are no eclipses of the Satellites (the interior excepted) until near the time when the Ring is seen edgewise. The most distant is by far the largest, and probably not much inferior to the Planet Mars in size, viz. 4,100 miles. The Moons of Saturn have not been as closely observed as those of Jupiter.

Astronomy still has much to learn of the smaller Planets, which, as before stated, are situate between Mars and Jupiter. Sir John Herschell notices Pallas only. A great difference of opinion existed as to the size of those Planets, between his late father and the celebrated German astronomer Schræter, who makes them all of greater dimensions than Herschell. I agree with Schræter, and reject Herschell's measurement. The extreme minuteness of the Planets is the cause. Ceres, the largest of them, is as large as our Moon,—still they revolve round the Sun in elliptic orbits, as regularly as the immense Jupiter or Saturn, strictly fulfilling the laws and periodic times of Kepler, who may with truth and without flattery, be styled the Prophet of Astronomy ; all his observations, save a few fanciful allusions, being verified by the results, on the progressive improvement of Telescopes. I will here observe that the Moons invariably revolve from west to east, with the exception of the Moons of Uranus, which revolve from east to west, strictly following the analogy of the Planets, and of our Satellite, in their revolutions round the Sun.

LETTER IV.

If the immense distance of the outermost Planet Uranus, (900 millions of miles from the Sun) precludes us of all hope of arriving at a perfect knowledge of its physical state, the minuteness of the four smaller planets operates in like manner. One of them, Pallas, has a hazy atmosphere, little condensed by the inadequate gravity of so small a mass. A man (says Sir John Herschell) placed on one of them would spring with ease sixty feet high, and be no more hurt than if he leaped one yard high on our earth. On such planets giants might exist, and those enormous animals which on earth require the buoyant power of water to counteract their weight, might then be inhabitants of the land. Ceres is of a ruddy colour though not deep, appears as a star of the eighth magnitude ; her atmosphere like the earth's, is very dense near the Planet, and becomes rarer at a greater distance, which causes her diameter apparently to vary. The Planet Juno is of a red colour, and is free from the cloudy atmosphere which surrounds Pallas. It appears from the close observations of Schræter that she has an atmosphere of great density,—a very remarkable variation in her brilliancy has been observed by him. The planet Vesta is as a star of the fifth or sixth magnitude, and may be seen in a clear evening by the naked eye—its light is more intense, pure and white, than that of the others—it resembles Uranus—it is not nebulous or cloudy. Herschell could not perceive its disc. It is needless to give their dimensions, the truth is, telescopes must be greatly improved before they can be accurately discerned. However, it occurs to my judgment, that the circumstance of Vesta being frequently visible to the naked eye proves her diameter greater than that of her sister planets. Having discussed the phenomena of the ten planets of our system, the larger of which I am confident are inhabited, and the smaller may have inhabitants also, we now recur to our own Satellite, of which we know most by observation, and in the discovery of the real state of which Schræter has taken more pains and been more successful than any astronomer, antient or modern. He measured the projections of the shadows of the mountains in the moon with micrometers, when the sun was near the horizon, and is either about to leave the Moon in darkness, or advance to the meridian. From the distance of the mountains from the boundary between light and darkness, we presume that he finds the altitude of the sun above their horizon, and thus deduces the altitude of the mountains. In this way he has also measured the depth of her immense cavities; and by his long continued observations it appears, that the Lunar Mountains exceed those on our Earth in height. In my opinion he was far more likely to measure accurately the mountains in the Moon, clear and unobscured by clouds, than in Venus. (He measured four mountains in Venus, two in Mercury.) I cannot credit his statement of one of those mountains in Venus being 22 miles high, the second 18 miles, third and fourth 10 and 11 miles high: that is more than four-fold the height of Chimborazo. Those in Mercury he gives, the first 18 miles, the second 10 miles. These results I decline complying with; but I am also confident that Schræter, the first practical astronomer of his time, would not assert a wilful falsehood. We are bound to use the reason that

God has given us, and not be led by fancy even in those sublime but occult discussions. Schræter and Tobias Meyer, (both Germans,) have given a catalogue of upwards of four hundred districts of the Moon, all named, as are the principal mountains and vallies also in that Satellite.

In my first Letter I observed that the mountains in the Moon were very numerous, occupying the greater portion of her surface. Herschell and Schræter both agree that water in any quantity does not exist in the Moon, nor am I at all inclined to imagine she has an atmosphere of much density, or is inhabited. Sir John Herschell was sent (in 1832) at the expense and by order of our government, to make observations on the fixed stars apparent in our most southern latitudes. For this purpose he repaired some years ago to the Cape of Good Hope, with a complete astronomical apparatus. Tho' I have anxiously sought an account of him or of his labours, I can find none. The Emperor of Russia has ordered an Observatory to be erected at Dorpat in Russia, where Professor Struve now dwells; and the German opticians, the best in Europe, are vying with each other in the construction of telescopes. If they succeed we will soon learn the real state of the Lunar phenomena, where improvements in our knowledge of astronomy must commence. The immense range of mountains, and the insulated hills that mark the surface of the Moon, have evidently no analogy with those on our own globe; they bear however a stronger resemblance to the towering sublimity and terrific grandeur of the Alps, and to their ruggedness, than to the tamer irregularities of less elevated regions; huge masses of rock rise at once from the plains, and elevate their peaked summits to an immense height in the air, while projecting crags spring from their rugged flanks, and threatening the vallies below, seem to bid defiance to the laws of gravitation. Around the base of those frightful regions, are strewed numerous loose and unconnected fragments, which time seems to have detached from the parent mass; and when we examine the ravines which accompany the overhanging cliffs, we expect to see them torn from their base, and that the process of destructive separation is about to be exhibited in tremendous reality. The strata of Lunar mountains called the Appenines, which traverse a portion of her disc, arise with a precipitous and craggy point from the "*Mare Imbrium*;" in some places their elevation exceeds four miles. The analogy between the Earth and Moon fails in a more remarkable degree, when we examine the circular cavities that appear in every part of her disc; some of the immense cavities are four miles deep and forty in diameter.—A high annular ridge marked with lofty peaks andlittle cavities generally encircle them,—an insulated mountain frequently rises in their centre; these hollows are most numerous in the South West part of the Moon—hence its peculiar brilliancy. The ridges which encircle the cavities reflect the most light, and appear near the time of full Moon like a number of brilliant radiations issuing from the large spot called Tycho. We will still continue the subject of the new discoveries in the Moon, as the most interesting to us from its proximity—and from the high scientific character of the Astronomer Schræter.

LETTER V.

Of Ctesiphon, (on the Tigris,) the renowned City of the Parthian Kings, it is reported by all travellers, that not a blade of grass sufficient to cover the smallest insect under heaven, or a drop of water to allay its thirst, is now visible on the site of its immense ruins. I am of opinion, that when human art hereafter, and probably at no distant time, shall have improved Telescopes to the highest perfection, that the Moon will exhibit the like or similar scenes of devastation and aridity. By persons uninformed in science, it is wondered at and even doubted, that our Moon is generally of an aspect so very mountainous and broken. To this we reply, that her surface is admirably fitted by her Divine Author for the reception of and the transmission of the Sun's light to our earth; were her surface smooth she could neither receive nor reflect light, and it is highly probable that at a future period the Moons of Jupiter, of Saturn, and of Uranus, will be found in geological construction, very similar to our useful Satellite. Schræter admits the rarity of the Moon's atmosphere,—that of the Earth he states to be forty-five miles—the Moon's only fifteen hundred feet in height.

In explanation of the Lunar caverns, it is difficult to explain the formation of these immense cavities; but we think our Earth would assume the same figure, if all the seas and lakes were removed; it is therefore probable that the Lunar cavities were either intended for the reception of water, or that they are the beds of seas or lakes, that have formerly existed in the Moon. There being no water apparent is a strong confirmation of this theory. The deep caverns which appear in almost all parts of the Moon's surface, have induced many astronomers to believe that they have a volcanic origin. This opinion first maintained by the learned Hook, was supported by others and opposed by few. Many Astronomers have observed the progress of volcanoes before Herschell had formed his great reflector. This Telescope, formerly forty feet in length, has been altered, and the glasses are now inserted in tubes of twenty feet, the former having been found by experience, extremely difficult to manage, as frequently a delay of one minute defeats the object of a celestial observation. Herschell's observatory still remains at Slough, near Windsor, (England.) The observatory of the learned Schræter, at Lilienthal, near Bremen, (Germany,) was destroyed by the French in the German wars. Philip the Second, on the loss of his armada, by tempests, said that "he did not wage war with the elements;"—this was nobly expressed. We would imagine the French the last nation of Europe who would destroy an Observatory, and thus wage war with the sciences. Such are the terrible evils of war, ever deprecated by good men.

To continue on the Moon.—On May 4, 1783, Dr. Herschell saw a luminous point in the obscure part of the Moon, and two mountains. In 1787 he saw similar objects, which we will describe in his own words. "On 19th April, 1787, I observed three volcanoes in different places of the dark part of the new Moon. Two are nearly extinct, or ready to break out, which may be decided next lunation ; the third shows an active eruption of fire or luminous matter ; I measured the distance of the crater from the northern edge of the Moon—its light is much brighter than the comet discovered at Paris the 10th of this month. April 20th, 1787.—The volcano burns with greater violence than last night ; I believe its diameter cannot be less than 3 deg. by comparing it with Uranus. As Jupiter was near, I turned the telescope to his third Satellite, and estimated the diameter of the burning part of the volcano to be equal to at least twice that of the Satellite, (three miles in diameter.) The figure is irregular and round, sharply defined on the edges. The other two volcanoes are much further towards the centre of the Moon ; no well defined luminous spot can be observed in them. The three burning spots are plainly to be distinguished from the rest of the marks on the Moon, for the reflection of the Sun's rays from the Earth, is in its present situation, sufficiently bright with a ten feet reflector, to show the Moon's spots, even the darkest of them. Nor did I perceive any similar phenomena last lunation. The appearance of what I have called the actual fire or eruption of a volcano, exactly resembled a small piece of burning charcoal, when covered with a very thin coat of white ashes, which frequently adhere to it when it has been some time ignited ; and it had a degree of brightness about as strong as that with which such a coal would be seen to glow, in faint daylight. All the adjacent parts of the volcanic mountain seemed to be faintly illuminated by the eruption, and were more obscure as they lay at a greater distance from the crater.—This eruption resembles much what I saw in May 1783, an account of which I will communicate to the Society. It differed much however in magnitude and brightness ; for the former volcano, though much brighter than that now burning, was not large in the dimensions of its eruption. The former seen in the telescope resembled a star of the 4th magnitude, as it appears to the natural eye.—This on the contrary shows a visible disc of luminous matter, very different from the sparkling brightness of star light." Here his observations on volcanoes end.

Dr. Olbers, of Bremen, (Germany,) discovered two craters, which were wanting in Schræter's charts, who had frequently examined this section of the Moon under favourable angles of illumination, but had never seen a trace of those craters. He, however, found them; they were very deep, and surrounded by an elevation of little brightness.

The existence of a lunar atmosphere has long been a disputed point. The constant serenity of the Moon's surface, undisturbed by clouds, induced astronomers to believe that she could not have an atmosphere, and this opinion was signally confirmed by the brilliancy of light retained by the fixed stars and planets, when nearly in contact with the limb of the Moon, and when their light must have passed through her atmosphere. M. de Fouchy in a memoir on this subject, endeavours to show that the duration of eclipses and occultations ought to be diminished by the refractive power of the Moon's atmosphere. In the eclipse of the sun which occurred in 1724, total darkness continued two hours sixteen minutes, which De Fouchy contends would never have happened had the Moon even the rarest atmosphere. On the other side, the aspect of the Moon's limb in total and partial eclipses of the Sun, has suggested arguments for a lunar atmosphere. In the year 1605, Kepler perceived that the Moon in a solar eclipse was surrounded with a luminous ring, most brilliant on the side nearest the Moon. The same was observed by Wolf the very next year. At Geneva a luminous ring was seen round the Moon. In a total eclipse of 1745, Dr. Halley observed a diminution of light in the limb of the Sun which was emerging before total darkness. The appearance also of the stars and planets when eclipsed by the Moon, furnish us with additional proofs of a lunar atmosphere. In the occultation of Saturn, observed June 17, 1763, the ring and the body of Saturn appeared affected by the proximity of the Moon, and resembled a comet at the moment of emersion. Mr. Schræter (so often mentioned with great respect in these letters) had perceived that the high ridges of the mountains Leibnitz and Doverfell—the former he computes twenty-five thousand feet in height, (five miles)—were less illuminated than the other parts of the Moon's disc. He also observed several obscurations and returning serenity, eruptions and other changes in the Moon's atmosphere, from which he was led to expect that a faint twilight might be perceived towards her cusps (as was the case from his observations on Venus.) The occultation of Jupiter, April 7, 1792, was observed also by him—some of the Satellites became indistinct on the limb of the Moon, while others remained unobscured—the belts and spots of Jupiter also appeared very distinct, when close to the limb of the Moon. These observations, however, have failed to convince me of the existence of a lunar atmosphere of any great density or extent.

LETTER VI.

Having given in those Letters the most satisfactory account of the Planets in general, and of the Moon in particular, that we could possibly collect, we will observe that there is no Science which requires more candour of disposition, and openness to conviction than Astronomy. Almost all its conclusions stand in open contradiction with those of superficial and vulgar observation, and with what appears to every one, until he has understood and weighed the proofs to the contrary, the most positive evidence of his senses ; thus, the Earth on which he stands, which has served for ages as the unshaken foundation of the firmest structures, either of art or nature, is divested by the Astronomer of its attribute of fixity, and conceived by him as turning swiftly on its axis, and at the same time moving onward through space with great rapidity. The Sun and the Moon, which appear to the uneducated round bodies of no very considerable size, become enlarged by the Astronomer into vast globes. The Moon 2,200 miles in diameter, and the Sun immensely larger ; the Planets, which appear like stars somewhat brighter than the rest,—are to the Astronomer spacious, elaborate, and habitable worlds, some of them vastly greater, and far more curiously furnished than the Earth, as there are also others less so ; and the Fixed Stars, which present only lucid sparks and brilliant atoms, are to him Suns of transcendant glory,—so that, when after dilating his thoughts to comprehend the grandeur of those ideas his calculations has called up, and exhausting his imagination and the powers of his language to devise similies and metaphors illustrative of the immensity of the scale on which his universe is constructed, he shrinks back into his native sphere, he finds it in comparison a mere point, so lost even in the minute system to which it belongs, as to be invisible and unsuspected from some of its principal and remoter members.

The object of these letters, strictly didactic, is simply to teach what we have known heretofore by celestial observation, and what we have since acquired by reading and reflection. The moderate limits of Ten Letters, and the necessity of every point being treated on, within that limit rather diffuse in explanation, (for instance our notices of the Moon,) as also the eminently matured and ascertained character of the science itself, render this course both practicable and eligible ; as there is no danger at this advanced period of the science, of any revolution in astronomy, like those which are daily changing the features of the less advanced sciences, calculated to destroy our hypotheses, and to confuse our statements.—Writing only to be understood, and to communicate as much information in as little space as possible (as in our Letters on Prophecy,) we can afford to make no sacrifices, to system, to form, or to affectation.

We now proceed to discuss the subject of Comets, one of which has visited us this season ; and of whose visit we have direct evidence in the length and severity of our winter, all over this earth. Previous to our commencing a discussion on Comets we will offer some observations. The work on Astronomy by Sir John, son to the late Sir William (or Dr.) Herschell, displays much ability and knowledge of the science. He omits not to mention all his father's observations and their results ; but he is not equally just to the merits of other eminent astronomers. Schræter he mentions once only (I believe) and that incidentally ; and of Horrox he makes some slight mention, (in a note) as an honor and an ornament to astronomy, though he had a fair opportunity in describing Venus and her Transits. Kepler he justly styles Illustrious—his fame is everlasting. His father, though surveying the heavens with his powerful telescopes, from 1780 to 1801, never discovered the four minor Planets, or even suspected them, lying between the orbits of Mars and Jupiter. Nor did Schræter discover any of them. The theory (I believe invented by Herschell,) that these were the broken parts of a great Planet destroyed by an explosion, was, and is quite too absurd to be credited. Herschell was evidently jealous of their discovery by others, and labours hard to make them as insignificant as possible. He says the largest of them does not exceed in size a Scotch estate (80 miles.) My opinion is, that if they were so diminutive, they would require telescopes such as have not yet been invented by the art of man ; and Schræter in my judgment, fairly accounts for the errors of Herschell in their diameter. The success of his observations on Saturn, on his double concentric ring—on his moons, particularly his discovery of the two interior (on the edge of the ring) prove the great power of his telescopes—as still more decidedly his discoveries among the fixed stars and nebulæ. Honor we are disposed to give where honor is justly due. Herschell has also observed and notices the retrogade movements of the two Satellites of Uranus, contrary to the Laws of Kepler, which his son (by observation) confirms. They move from east to west. Equal in ability to any of the present race of astronomers, is a female, Mrs. Somerville, wife to a Scotch clergyman. Her correspondence with Laplace, whose work "Mechanique Celeste," is next in credit to Newton's Principia, and her own original works (the latest of which she dedicated to the Queen of England,) prove her superior capacity and acquaintance with mathematics, a perfect knowledge of which, and of trigonometry in particular, are indispensable to the practical astronomer. Miss Herschell is also much celebrated for her acquirements.

We proceed from this digression to the subject of

Comets. Their extraordinary aspects, their rapid and apparently very irregular motions, the unexpected manner in which they often burst upon us, and the imposing magnitudes which they at times assume, have in all ages rendered them objects of astonishment, not unmixed with superstitious dread to the ignorant, and a complete enigma to those conversant with the wonders of creation. No rational account of their Tails (so called) has ever been given. In a list cited by a celebrated French astronomer (Lalande,) 700 comets are noted—their actual number are many thousands. Many indeed must escape observation by reason of their courses, traversing only that part of the heavens above the horizon in the day time ; such Comets are seldom visible in a total eclipse of the sun, one of which happened, by Pliny's account, sixty years before Christ, when a large Comet was actually observed near the sun. Several have been seen even in the daytime. That feelings of awe and astonishment should be excited by the sudden appearance of a great Comet, is not surprising, being the most brilliant and imposing of all natural phenomena. Comets consist of a large and splendid but ill defined nebulous mass of light, called the head, which is usually brighter towards its centre, and appears of a vivid nucleus like a star or planet. From the head appear to diverge two streams of light, which grow more diffused at a distance from the head, and which sometimes close in and unite at a little distance behind it, sometimes continue distant for a great part of their course, producing an effect like the trains left by some bright meteors, or like the diverging fire of a sky-rocket, without sparks or perceptible motion—this is the Tail. This magnificent appendage attains occasionally an immense apparent length. The Comet of 1680, the most celebrated of modern times, was the most remarkable of all, with a head not exceeding in brightness a star of the second magnitude.

LETTER VII.

The great Comet of 1680, referred to in my last Letter, covered with its Tail an extent of more than seventy degrees of the heavens, or as some state, ninety. The Tail is by no means an invariable appendage to Comets, many of the brightest have short and feeble tails, and many more want them totally. Cassini describes the Comet of 1682 as being as round and as bright as Jupiter. Some Comets still have many tails, or streams of diverging light; that of 1744 had six tails, spread out like an immense fan, extending to a distance of nearly 30 degrees in length. The most unsubstantial clouds which float in the highest regions of our atmosphere, and seen at sunset to be drenched in light, must be considered as dense and massive bodies, compared with the filmy texture of a Comet. Accordingly, whenever observed with powerful Telescopes, we dispel the illusion which gives solidity to the head, though it is also true that in some a very minute stellar point has been seen, indicating the existence of a solid body.

We now come to speak of the motions of Comets; these are irregular and capricious,—sometimes they remain in sight only a few days, at other times for many months; some move with extreme slowness, others with immense velocity. The great Comet of 1472, described an arch in the heavens, of 120 degrees in extent, in a single day. They do not confine themselves like the Planets, to a certain region of the Heavens, but traverse every part; their variations in apparent size during the time they continue visible, are no less remarkable than those of their velocity; their tails increase in length and brightness till they approach the Sun, and are lost in his beams. After a time they again emerge on the other side, receding from the Sun with a velocity first rapid, but gradually decaying. It is after passing the Sun, and not till then, that they shine forth in all their splendour, and their tails acquire the greatest length, thus plainly indicating the action of the Sun's rays as the exciting cause of that emanation. As they continue to recede from the Sun their motion diminishes, and the tail dies away. Without the clue furnished by the theory of gravitation, the enigma of these irregular movements might have remained for ever unresolved. Recently two Comets have been identified as having performed several revolutions about the Sun. The first of these is called from Professor Encke, of Berlin, who first ascertained its periodical return. From the ellipse calculated by Encke, (in 1819,) its return in 1822 was predicted by him, and observed in New South Wales by Mr. Rumken, being invisible in Europe. Its next return was in 1835, (as we have witnessed.) The other Comet lately discovered, is that of Biela, who first noticed it. Its last appearance took place in 1832,—the next will be in 1838. It is a very small Comet without a tail, its orbit by a remarkable coincidence, very nearly intersects that of the Earth, and had the Earth, at the time of this Comet's passage in 1832, been one month in advance of its actual place in the heavens, it would have passed through the Comet, which probably would be attended with danger.

Having discussed as fully as our limits will admit of, the subject of Comets, we next proceed to consider the Fixed Stars. Besides the bodies we have described, the Heavens present us with an innumerable multitude of other objects, which are called Stars. The aspect of the Firmament, as it appears to the naked eye, is calculated alike to excite curiosity and admiration; but when we ascertain that the solid contents of the Sun exceed that of our Globe above a million of times, and that its distance from us is immense, namely, ninety-five millions of miles, (Herschell supposes the Sun an inhabited world,) the mind becomes overpowered, and seeks in vain to discover anything like an adequate solid of such magnitude of matter, and of quantities of space. Many of the Fixed Stars being Suns, dispensing light and heat to other countless worlds, classing our Sun with the Stars is just analogy. Though comprehending Stars differing from each other not merely in brightness, but in other essential points, they all agree in one attribute, a high degree of permanence as to relative situation. This has procured them the title of Fixed Stars, which may be understood in a comparative and not in an absolute sense, it being certain that many and probably all, are in a state of motion, although too slow to be perceptible unless by means of very delicate observations, continued during a long series of years. Astronomers are in the habit of distinguishing the Stars into classes, according to their apparent brightness—these are termed magnitudes. The brightest are classed in the first magnitude, and so in succession; and sizes from the 8th to the 16th are familiar to those Astronomers using powerful instruments—nor is there a limit to this progression. Such is the view taken by the late Sir William Herschell—so crowded are they in some parts of the region called the Milky Way, that by counting the Stars in a single field of his Telescope, he concluded that five thousand had passed under his review in a zone of two degrees in breadth, during a single hour's observation. It is certain that light takes one thousand years to travel from some of the Fixed Stars to us,—and it has been calculated that a cannon-ball flying at the rate of 450 miles in an hour, would not reach Sirius from our Earth in 700,000 years. The light of many Stars has not reached our earth since the creation. Astronomers conjecture the distance of Sirius from us at twenty billions of miles—and Dr. Wollaston has concluded the light and heat of Sirius to be equal to fourteen of our Suns. Whilst the writer was an undergraduate in the University of Dublin, the Rev. Dr. Brinkley, (lately deceased Bishop of Cloyne, in Ireland), was Regius Professor of Astronomy. He concluded by a series of observations long continued on Lyræ, one of the Fixed Stars, that he had discovered its parallax; and on that interesting subject had a correspondence with many scientific persons in Europe, also with an eminent astronomer, the late Professor Playfair, of Edinburgh.—Dr. Brinkley was, however, mistaken—Astronomers are not infallible. The great Kepler, by too strict a dependance on the Rudolphine Tables, then, in A. D. 1600, in great credit, miscalculated the time of the Transit of Venus, which he fixed for the year 1631. Horrox, who depended solely on his own tables, calculated the Transit to occur in November, 1639, corresponded with his friend William Crabtree, of Manchester, and was the first to observe the glorious sight of Venus, with her mountains, seas, continents, and forests, visible as a well defined black spot on the Sun's disc. Observe, the diameters of Venus and our Earth are nearly equal. The next Transits will occur—first, on December 8th, 1874,—second, on December 6th, 1882. Bishop Brinkley mentions Horrox in his work on Astronomy, in a manner highly creditable to that prelate as a scholar, and to the extraordinary talents of that lamented youth.

LETTER VIII.

We have arrived near the conclusion of this Series. I will now enquire for what purpose are we to suppose such magnificent bodies scattered through the abyss of space, as the Fixed Stars are. Surely not to illuminate our nights, which an additional Moon, infinitely smaller than our Satellite, would do much better ; nor to sparkle as a pageant void of meaning and reality, and bewilder us in vain conjectures. It is surely true they are to man as "points of exact and permanent reference," but that man must have studied this noble Science to little purpose, who can suppose man to be the only object of his Creator's care ; or who does not see in the vast and wonderful apparatus of Planets around us, the provision for other races of animated beings. The Planets derive their light from the Sun, but that cannot be the case with the Fixed Stars ; these doubtless then, are themselves Suns, and may perhaps each in his sphere, be the presiding centre round which other Planets or bodies, of which we can form no conception from any analogy offered by our own system, may be circulating within the bounds of infinite space. Of the Fixed Stars Aldeberan is red, Lyræ a fine purple, Sirius a brilliant white.

In my last Letter I imputed an error to the Illustrious Kepler. As I hold in such respect the memory of that great Astronomer, that his name can never be even mentioned in my hearing, without exciting feelings of admiration, I now proceed, (as in candour bound,) to do him justice. The error I was led into by an imperfect edition of Ferguson's Astronomy (Edinburgh, 1812.) On close reading and research, I find in a History of Astronomy, published by order of the Society for Promoting Useful Knowledge, (of which Lord Brougham was President,) page 61—Kepler had once imagined that he had observed a Transit of Mercury, on May 28th, 1607; but he soon admitted his error, and frankly confessed that he had mistaken a Solar spot, for the Planet on the Sun's disc. The Transit announced by Kepler, of Venus, actually occurred on December 6, 1831, after his decease; but it unhappily took place in the night, of course unobserved. "There lived," say the Editors of this History, "at an obscure village of Lancashire, England, (Hool, near Liverpool,) a young Astronomer, by name Horrox, who though he died prematurely at the age of twenty-two, has left behind him proofs of enthusiasm and genius for this magnificent science altogether wonderful." Thus I again find I am not singular, in my admiration of the transcendant merit of that estimable youth.

Fixed Stars of the 1st magnitude, are only twenty in number. These must be Suns illuminating other systems. These Stars much surpass our Sun in light and heat, as before stated respecting Sirius. The discs which the best Telescopes show us, of the stars, are not real, but spurious (an optical delusion;) their light therefore must be our only guide. Stars of the 2d magnitude are sixty in number; and there are two hundred of the 3rd magnitude. Stars classed as temporary, have appeared in different parts of the heavens, blazing with intense lustre, and have died away, and left no trace. Such a Star attracted the observations of Hipparchus, and induced him to make up a catalogue of the Stars, the first on record. Such also was the Star which blazed forth A. D. 389, near Aquila, remaining for three weeks as bright as Venus, and then totally disappearing. In succeeding years brilliant Stars appeared in the regions of the heavens, between Cepheus and Cassiopea. The appearance of the Star of 1572, was so sudden, that Tycho Brahe, a famous Danish Astronomer, returning one evening (the 11th of November,) from his Observatory to his house, was surprised to see a group of countrymen gazing at a Star which he was certain did not exist half an hour before. It was then as bright as Sirius, and continued to increase till it surpassed Jupiter in brightness, and was visible at noon day. It began to diminish in December, and in March 1574, it had vanished totally. So also on the 10th October, 1604, a Star of the same kind, and not less brilliant, burst forth in the constellation of Serpentarius, which continued visible till October, 1605. Similar instances, though of less splendid character, have occurred more recently, as in the case of a Star of the 3d magnitude, discovered in 1670, in the head of the Swan, which after disappearing, reappeared; and after undergoing one or two fluctuations of light, during two years, at last died away totally. Many stars are also missing. Some are found double, some treble. Sir William Herschell has noticed 500 Double Stars; and Professor Struve, of Dorpat, (his telescopes being better fitted for observations,) has noticed five times that number; others also have extended the catalogue. Many of the Double Stars exhibit the curious and beautiful phenomena of contrasted colours; in such cases the larger star is generally of a ruddy or orange hue, while the smaller appears blue or green,—thus, a yellow predominating in the brighter, that in the less bright will appear blue, while if the colour of the brighter be crimson, the less bright will be green. The former contrast is exhibited by Canchri, the latter by Andromeda, both fine Double Stars. Cassiopea exhibits the fine combination of a large white star, and a small one of a rich ruddy purple. The Nebulæ furnish a boundless field of speculation and of conjecture—the greater part of them by far, consist of stars, and in the interminable range of system upon system, the imagination is quite bewildered and lost.

LETTER IX.

The great improvement in the Science of Astronomy will appear and be obvious to all. At the end of the fifteenth century, a catalogue of the Fixed Stars up to that time discovered, by Tycho Brake, Kepler, and by others, averaged fifteen hundred only. At the end of the sixteenth century, Flamstead doubled that number to 3000. In the seventeenth century, Lalande's Catalogue was published, containing upwards of fifty-thousand stars, and the number still increasing. Sir Isaac Newton, and Astronomers before his time, considered the Sun a vast body of fire. What are called Spots on the Sun are really the opaque body of the Sun, appearing through breaks in his atmosphere; some are as large, or even larger than our Earth. The Sun is four-hundred times as distant from the Earth as the Moon; our distance from the Sun has been before stated—his real diameter is ascertained, and is eight-hundred and eighty-two thousand miles. The Sun is composed of matter much less dense than the Earth, and is surrounded by different strata of highly resplendent, and vast numbers of luminous clouds, whence arise his light and heat. The elder Herschell having given up the Moon to Schræter, has devoted much time and attention to the Solar orb. His observations on its nature and properties appear very rational and conclusive. He computes the height of many Solar Mountains at 300 miles —this I think very incredible. The application of his powerful reflecting Telescope has expanded the heavens in a degree unknown, and even unanticipated, unless by Kepler and Newton. Fancy, which was admissible in the infancy of the Science, cannot in its present matured state, be tolerated. We must in future depend solely on reason and observation.

Previous to the establishment of the laws of gravitation, by Newton, several discoveries had been made, which opened the way to finding the Laws by which the motions of the Planets round the Sun were regulated; these were known by Kepler, and called the Laws of Kepler. They indeed form the basis of the Science. The first is—that the Planets do not move in circles as supposed by Copernicus, but in ellipses or ovals. The second, that an imaginary straight line from the Sun to the Planets, always describes equal areas in equal times. The third, and by far the most remarkable and important is, that in the motion of the Planets, the squares of the periodic times of revolution, are as the cubes of the mean distances from the Sun. It is quite incompatible with our limits, to enter into any details respecting these important Laws ; it is sufficient to observe that the application of them affords a fine explanation of the movements of the bodies composing our Solar System.

Concerning "Perturbations," on which Mrs. Somerville has lately written in a most talented manner, that title has been applied to those irregularities in the Lunar and Planetary motions which arise from the universality of attraction, Thus, not only does the Moon attract the Earth, and the Earth the Moon, but the latter attracts the former, and both are again attracted by the Sun ; but in the lesser Systems, as in the Satellites of Jupiter, the Perturbations thus arising, though insensible in short intervals, become apparent when accumulated, and greatly derange the elliptic motions and relations. The calculation of the effects of these disturbing forces are famous in the history of analysis. We cannot here exhibit these nice calculations, nor would they suit our readers. Of its great difficulty some idea may be formed, when we consider what is apparent to all—that the Planets are constantly changing their relative distances from each other. The attraction of Jupiter and of Saturn (the largest of the Planets) frequently delay Comets in their course, and prevent their appearance at the times predicted. The attraction of Jupiter retarded the Comet of 1759, 518 days ; the attraction of Saturn retarded it 100 days.

The works of a celebrated female (Mrs. Somerville,) are written in a style of scientific ability, quite beyond the reach of the uninstructed in Astronomy. I have read extracts from her late work on "Perturbations," which would have done credit to Sir John Herschell, or to Laplace. Lord Bacon says "Knowledge is Power ;" and the mother of the celebrated oriental scholar, Sir William Jones, on his enquiring from her, whenever he met with difficulty in his studies, replied "Read with attention, and you will then know." The writer of these sheets has spent all his life in the acquisition of knowledge, and he finds he has much yet to learn. Newton modestly compared himself "to a child picking up pebbles on the sea shore, whilst the great ocean of truth lay undiscovered before him. The Mechanics' Institute of Halifax, promises to afford much benefit in exciting and cherishing a disposition in the people to Literature in general, and to Science in particular. Ignorance is the mother and the nurse of selfishness, and of all evil—this I know and have felt to my cost, during my residence in Nova Scotia. As the man who puts his hand to the Gospel Plough, and looks back, is pronounced by our Lord as unfit for his spiritual kingdom, so the man (the young man I mean,) who commences a course of liberal study, must persevere. If his memory be weak, he may take notes ; this, though gifted with a highly retentive memory, I have found an excellent plan. Nova Scotia need not despair, some of her sons may at a future and no very distant time, do her credit. The fine Prophecy of Virgil in his "Pollio," may then be realized even here.—

> "Alter erit tum Typhis, et altera quae vehat Argo
> Delectos heroas ; erunt etiam altera bella,
> Atque iterum ad Trojam magnus mittetur Achilles."

A glance of the view we have just given of the Solar System, must convince us, that the power of gravity of any given Planet, will be in proportion to the mass of matter that it contains ; hence we calculate that bodies weigh three-fold more on Jupiter than on our Earth, on the Moon only one-sixth, while Saturn is much less dense than Jupiter ; but with respect to temperature we cannot so well decide. We may speculate that Mercury endures a heat much above that of boiling water ; and that Saturn and Uranus, from their great distance from the Sun, must be for ever bound in chains of thick ribbed ice ; but the manner in which heat exists on our Earth, is by no means settled. We know that both heat and light (apparently) proceed from the Sun ; but the effect may be produced by some peculiar action which the Sun exercises on a rare etherial medium. With regard to inhabitants, all we can presume is, that (reasoning from analogy) they must be inhabited ; if not, pray for what purpose were so many Moons given to the larger Planets ? If for instance, upon our Earth there is not one withered leaf that strews the forest, or is found upon the heath, but teems with animated life, we are quite reasonable in stating our decided conviction, that they abound with creatures fitted to their respective climates.

Saturn takes nearly thirty years in his Solar Revolution ; Jupiter takes twelve years ; Mars takes four years ; Venus and Mercury a much shorter period ; Uranus from his immense distance, a still more protracted period of revolution than any of the rest. Jupiter is thirteen times larger than the Earth, and in the same ratio less than the Sun. More Planets of our Solar System probably exist, and may be hereafter discovered.

P. S. I am happy to learn that Dr. Olbers, of Bremen, has received ten-thousand francs from the French Institute as a reward for his discoveries of the minor Planets, and his labours on the Moon.

LETTER X.

Having finished Nine Letters illustrative of this most sublime and interesting Science, on further enquiry and research, we find ample materials for a Tenth Letter, which will conclude the Series. That Astronomy is of great importance will appear from the efforts of all civilized Nations, in enlarging its boundaries and rewarding those who have expended their time and talents in this noble study. Tobias Meyer (a German) for his labours on the Moon, received six thousand pounds sterling from our Parliament, and after his decease, (for he did not long survive, having certainly injured his health by intense mental toil and research,) his widow received a liberal Pension. Mrs. Somerville also has had a Pension. Sir John Herschell notices a young Astronomer of great promise, whom he styles " our young, talented, and unfortunate countryman, Mr. Gascoine," who was contemporary and corresponded with Crabtree and Horrox. They are honorably noticed by Derham, Phil. Trans. 30th, 6. Horrox, he styles, and justly so, the " pride and boast of British Astronomy." As early as 1640, Gascoine had applied

Telescopes with threads in the common focus of the glasses, to his quadrants and sextants, and had even carried the invention so far as to illuminate the field of view by artificial light, which he found "very useful during the Moon's absence." The able Astronomers of his time expressed freely their admiration of this and his various improvements in the art of observation. Gascoine however, was slain at the Battle of Marston Moor, at the early age of 23, and Horrox, (as before stated,) died suddenly at the age of 22, which calamities to Science will fully account for the temporary oblivion of the invention. Our Letters on Astronomy we trust will appear written with candour and strict impartiality ; we are not led by admiration of great names to adopt their errors ; we attach no credit to the elder Herschell's remarks on the four small Telescopic Planets, nor do we credit M. Schrœter's estimate of the height of the mountains in Venus and Mercury,—we are disinclined to swallow Whales. The discovery of mountains was a great effort of genius, when Herschell could not even perceive inequalities in their disc or surface. The discovery of the rotation of Venus and of Mercury on their axis, is also due to the talents and perseverance of Schrœter,—the spots certainly, are the shadows of the mountains, and the spots on Jupiter and Saturn are the shadows of the mountains in these immense Planets ; the height of which is possibly proportionate to the size of the Planets. It was by carefully watching the rotation of the spots that the movements of the Planets on their axis has been proved. Uranus has no spots discernible, therefore the period of his rotation is unknown.

We have stated that the Planets perform their circuit in the Heavens under very different circumstances ; this must be explained. Mercury and Venus attend on the Sun within certain limits, sometimes visible to the east and sometimes to the west of that luminary. In the former case they are visible over the western horizon first after sunset, and are called evening stars—Venus exhibits at times a dazzling lustre. When at the east of the Sun they rise before him in the morning and appear on the eastern horizon as morning stars ; they do not however, attain the same elongation from the Sun. Mercury goes no further than 29 degrees, whilst Venus extends to 47 degrees, and their continuance above the horizon after sunset becomes daily shorter, till at length they set before the darkness has rendered them invisible. For a time then they are invisible unless on very rare occasions, when they may be observed passing over the Sun's disc, as small, round, well defined black spots, totally different in appearance from the Solar spots. These phenomena are called Transits, and occur when the Earth happens to be passing the line of their Nodes, while they are in that part of their orbits. After being invisible for some time, they begin to appear on the other side of the Sun, at first showing themselves only for a few minutes before sunrise, and gradually longer as they recede from him; at this time their motion is retrogade; they at length become stationary in the Heavens. Mercury and Venus alone perform their Solar revolutions in the above manner, they are called inferior Planets.

Professor Struve, of Dorpat, has given the exact dimensions of Saturn's Rings, concentric with the Planet, and with each other. These results are confirmed in his late work, by Sir John Herschell, also by Schræter.—

Exterior diameter of exterior Ring	176,418	miles
Interior diameter of do.	155,272	do.
Exterior diameter of interior Ring	151,690	do.
Interior diameter of do.	117,339	do.
Equatorial dia. of body of Saturn	79,160	do.

Interior Ring 20,000 miles broad;
Exterior Ring 7,200 do.
Thickness of the Rings, 100 miles only.

The Rings of Saturn must serve as Moons to his polar regions.

I am at a loss to know, when the elder Herschell had the credit of observing Saturn with great assiduity for years, why we are indebted to others for his dimensions. His great distance from us could be no apology, as the Fixed Stars and Nebulæ are beyond comparison more distant. The most distant of his Satellites, which we have elsewhere stated as probably nearly the size of Mars, has alone elicited enquiry. This Satellite exhibits like those of Jupiter, periodic defalcations of light, which prove its revolution on its axis in the time of a sidereal revolution about Saturn ; the next in order is tolerably conspicuous ; the three next very minute, and requiring powerful telescopes ; while the two interior which just skirt the edge of the Ring, and move exactly in its plane, can only be discerned with the very best telescopes ever constructed. At the time of the disappearance of the Rings to ordinary telescopes, they have been seen by Herschell, in his great Reflector, threading like beads the thin fibre of light to which it is then reduced, and for a short time advancing off it, at either end, speedily to return and hastening to their habitual conceaiment. Owing to the obliquity of the ring, and of the orbits of the Satellites to Saturn's ecliptic, there are no eclipses of the Satellites (the interior excepted) until the time in which the Ring is seen edgewise ; these highly important observations are confirmed by both the Herschell's, and given to the public by Sir John Herschell.

This noble Science requires taste, talents, and warm feelings, industry and intense mental application, a strong memory also. Men of cold and phlegmatic tempers, can make no progress in Astronomy, it would be irksome to them. Whoever observes the Firmament will frequently see the Planet Venus either a morning or an evening star ; her superior and transcendant lustre will render her an object almost impossible to overlook ; indeed she at times, in the West Indies and other latitudes, casts a visible shadow on our Earth—her distance from the Sun is sixty-eight millions of miles. Mercury and Venus are styled Inferior Planets. The Superior Planets are not confined to certain limits of elongation from the Sun, but appear at all distances from him, even in the opposite quarter of the heavens, or in Opposition, when the Earth places itself between them and the Sun. They never appear horned like Venus or Mercury, or even semi-lunar, but always round—a proof that we see them in the direction not remote from that in which the Sun's rays illuminate them—proving also, that the Earth's orbit is inclosed within the orbits of the superior Planets, and of comparatively small diameter ; one only of them (Mars) exhibits any perceptible phase. Having given an ample description of Saturn, of his Rings and Satellites, we will offer some additional observations on those of Jupiter, which afford visible discs with good Telescopes, and are very brilliant ; but more for their eclipses, which afford signals of much use for the determination of Longitude on Earth, much more accurately attained however, by Lunar observation, as proved by Meyer and Schræter. The Satellites revolve from West to East ; we therefore observe their orbits projected nearly in straight lines, in which they appear to oscillate to and fro, at times passing before Jupiter and casting shadows on his disc, very visible in good telescopes, like small round dark spots, and sometimes receding behind the body, or being eclipsed in its shadow, at a distance from it. The three interior pass through the shadow, and are totally eclipsed each revolution ; and the fourth, though it (sometimes) from the greater inclination of its orbit, escapes and suffers partial eclipse, yet this is rare, and its eclipses happen like those of the rest, each revolution.

The Satellites, with their respective Primaries, form in each case miniature systems entirely analogous in the general laws of their motions to the great system in which the Sun acts the part of the Primary, and the Planets of its Satellites. In each of those systems the laws of Keplar are obeyed without prejudice to the effect of perturbations, and of that small but not imperceptible connection which arises from the elliptic form of the central bodies ; and in all of them it will be observed that the same remark respecting their proximity to their Primaries holds good, as in the case of our Moon with a similar reason for such close connection. In those Transits of the Satellites, which with powerful Telescopes may be observed with great precision, it often happens that the Satellite is discernible on the disc as a bright spot, if projected on a dark belt ; but at times also as a dark spot of smaller dimensions than the shadow. This curious fact (observed by Schræter and Harding) has led to a conclusion that some of the Moons have on their own bodies or in their atmospheres, obscure spots (as in the Planets) of vast extent; for the Satellites of Jupiter and of Saturn, small as they appear to us, are really bodies of great size, as we have before proved. The three Satellites of Jupiter cannot be eclipsed at one and the same time, for when the first is eclipsed the other two must lie between the Sun and Planet, casting their shadow on his disc, and vice versa. One instance only is on record, when Jupiter has been observed without Satellites, viz.—by Molyneux, November 2d, O. S., 1681.

The final and conclusive establishment of the Copernican System, may be referred to the discovery of the motions and eclipses of the Satellites, in which the famous Laws of Kepler, and especially that Law which connects their periods and distances, were clearly traced and fully maintained. To this cause we also owe the grand discovery of the aberration of light, and the enormous velocity of that element. The Orbits of Jupiter's Satellites are but little eccentric; their mutual action produces "perturbations" in them, similar to those of the Planets about the Sun, diligently investigated by the celebrated French Astronomer Laplace, and lately (as before said) with singular ability by Mrs. Somerville, of Scotland; by close observation it has been ascertained, that they are subject to marked fluctuations in respect to brightness, and that these fluctuations happen periodically, according to their positions with respect to the Sun. From this it has been fully concluded, that they revolve on their axes like our Moon, in periods equal to their sidereal revolutions round their primaries.

We heretofore observed, that the Moons of Saturn require more attention than has hitherto been paid to them. He is certainly inferior in density to Jupiter, but his being as light as cork I deny; as in that case the "perturbations" arising from the action and attraction of Jupiter, would not only encumber his motions, but actually force him from his position in the sky. That Comets are of a filmy texture, has been proved by the observation of Stars through their body. All the conjectures of Astronomers are not founded on fact or proof; for instance, Brewster says that Uranus has six Moons, others say he has Rings and seven Moons; Sir William Herschell who discovered him, and his Son who has frequently observed him with powerful telescopes, both join in stating that "he has certainly two Satellites, and that four more are suspected." I again say "suspicion is not proof;" but it is in my humble judgment highly probable, that Uranus from his bulk, (eighty times that of our Earth,) has four Moons at least; this is more probable than that he has two or six, when the immense Jupiter, three times his diameter, has four only. Except the two interior Satellites of Saturn on the edge of his Rings, the Moons of Uranus are by far the most difficult objects in the Solar System to observe. The elder Herschell has the credit of their discovery. Mercury I have never been able to see in his place in the Firmament. I have observed him however, from Halifax, being aware of his Transit (I think early in the Summer of 1830,) as a dark well defined spot of the size of a dollar, remaining for three hours on the Sun's disc—a partial eclipse of the Sun took place; my eye was protected by a smoked glass. Venus on the Sun, some of our children may observe twice in this century.

We will now close our labours with an illustration calculated to convey to our readers, a general impression of the relative magnitudes and distances of the Solar system. Select a level field, on it place a stone 9 feet in diameter, this will represent the Sun; Mercury will be a grain of mustard seed, on a circle 164 feet in diameter for its orbit; Venus a pea on a circle 284 feet in diameter; the Earth a pea, on a circle of 480 feet; Mars a large pin's head on a circle 654 feet; Juno, Ceres, Pallas, Vesta, grains of sand in orbits of ten or twelve thousand feet; Jupiter a large orange in a circle half a mile across; Saturn a small orange on a circle of 4-5ths of a mile; and Uranus a cherry or a small plumb, on a circle 1½ mile in diameter. To obtain correct information from childish toys called Orreries is futile. To imitate the motions of the Planets in their orbits, Mercu must describe its own diameter in 41 seconds; Venus in 4 minutes, 14 seconds; the Earth in 7 minutes; Mars in 4 minutes 48 seconds; Jupiter in 2 hours 56 minutes; Saturn in 3 hours 13 minutes; and Uranus in 2 hours sixteen minutes.

HENRY HAYDEN.

APPENDIX.

It has been thought proper to give the translation of the two passages from Virgil quoted in the foregoing pages, for the benefit of those who are unacquainted with the Latin:—

Translation. Page 6.

Ah! could'st thou break through Fate's severe decree,
A new Marcellus shall arise in thee!
Full canister's of fragrant lilies bring,
Mixed with the purple roses of the Spring:
Let me with funeral flames his body strew,—
This gift which parents to their children owe,
This unavailing gift, at least I may bestow.

Translation. Page 31.

Another Tiphys shall new seas explore;
Another Argo land the chiefs on the Iberian shore;
Another Helen other wars create;
And great Achilles urge the Trojan fate.

[FINIS.]